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FLORISTIC DIVERSITY OF THE *Lolio-Cynosuretum* R. Tx. 1937 ASSOCIATION AS AN INDICATOR OF HABITAT CONDITIONS

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Abstract. Changes in the floristic composition of meadows and pastures may provide information on the human impact on the habitat conditions and intensity of land use. The aim of the study was to present the floristic diversity of the *Lolio-Cynosuretum* association and its relation with the habitat conditions evaluated using the phytoindication method with Ellenberg indicators. The study was conducted in five river valleys in the years 1999-2012. For the analysis, 100 relevés were selected, which were subject to floristic, habitat (phytoindication), and statistical analysis. In the *Lolio-Cynosuretum* phytocoenoses, the total number of 178 taxa of vascular plants from 33 families was recorded. It was demonstrated that the differentiation in the floristic composition of *Lolio-Cynosuretum* phytocoenoses remains in relation with the habitat conditions, which may be evaluated basing on the ecological preferences of plant species that form the taxa. The species were established as differential for the lower units, that is four subassociations and eight variants.

Key words: floristic diversity, habitat conditions, *Lolio-Cynosuretum*, phytoindication, subassociations, variants

INTRODUCTION

Species composition of meadows, whose development is related to human activity, undergoes rapid transformations. This refers to a large extent to meadows and pastures of the *Molinio-Arrhenatheretea* class, which are characterized by high sensitivity to changes in habitat conditions often caused by pratotechnique treatments. The most frequently, changes in the humidity and habitat trophism affect the transformation of the floristic composition and disappearance of characteristic species combinations, the

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effect of which is diversification in phytocenoses within the association [Barabasz 1997]. Therefore, phytoindication diagnoses conducted with the help of the so-called index numbers may be a supplement to the classical phytosociological plant community analysis [Roo-Zielińska 2004]. They may establish a valuable tool for the evaluation of habitat conditions, including basic soil properties, useful for agricultural practice [Kostrowicki *et al*. 1992].

Numerous geo-botanical study results concerning specialised pastures that represent the alliance *Cynosurion* underscore their wide amplitude in relation to irradiation, humidity, soil pH, and in particular trophism [Roo-Zielińska 2004]. The association *Lolio-Cynosuretum* R. Tx. 1937 is an example. Its formation and maintenance is significantly affected by zoogenic and anthropogenic factors. The pastures are frequently seen in Poland, particularly in similar ecological conditions as fresh meadows. However, species composition of their sward is often modified by changing habitat conditions and utilization [Wrage *et al.* 2011, Opitz von Boberfeld *et al.* 2012].

The aim of the study was to present the floristic diversity of the *Lolio-Cynosuretum* association, which occurs in the valleys of several Polish rivers, and its relation with the habitat conditions evaluated on the basis of ecological index numbers [Ellenberg *et al.* 1992].

MATERIAL AND METHODS

Research was carried out in meadow communities *Lolio-Cynosuretum*, which varied in utilization intensity and were located in the valleys of five rivers: Barycz, Biebrza, Obra, Warta, and Wełna, in the years 1999-2012. From the basis of over 600 relevés, 100 relevés produced with the Braun-Blanquet method [1964] were randomly chosen for the analysis, more or less in equal quantity proportions from every valley (Barycz 24, Biebrza 15, Obra 16, Warta 23, and Wełna 22 relevés). Habitat conditions of the phytocenoses were evaluated on the basis of the photoindication method by Ellenberg *et al*. [1992], and the indicator values were obtained from the weighted arithmetic mean of the index number, while taking into account species coverage. The obtained results for every subassociation were processed in the Origin program [OriginLab, Northampton, MA] and presented graphically as charts of categorized box plots. Floristic composition was characterized in regards to: average species number in the relevés, species affiliation to the particular families, forage groups of plant participation [Filipek 1973], life forms [Zarzycki *et al*. 2002], geo-historical spectrum [Jackowiak 1990], and floristic diversity, with the use of the Shannon-Wiener index – H' [Magurran 1996]. Names of vascular plants are given after Mirek *et al.* [2002], syntaxonomic affiliation after Matuszkiewicz [2008], and subassociation names on the basis of the works by Szoszkiewicz [1967], Grynia [1967], Kucharski, and Michalska-Hejduk [1994].

Pasture utilization intensity, which took into account fertilization doses, density, and tending, was established in a three-degree scale: low (+), moderate (++), and high (+++) (Table 1).

Program Turboveg [Hennekens 1998-2004] was used for the collecting of phytosociologial data, and for phytoindicator and H' index calculations, program Juice 7.0 [Tichý 1999-2010] was applied. Moreover, analysis of relevé similarity was carried out with the use of program Twinspan [Hill 1979], which made it possible to distinguish lower community syntaxa, while naming the diagnostic species for the particular subassociations [Dzwonko 2007, Zarzycki 2009]. In order to differentiate the diagnostic species, calculations of the phi (ϕ) value were done, which evaluates species fidelity in relevé groups [Chytrý *et al.* 2002], by determining the relation between the species and syntaxa [Kącki *et al.* 2013]. Coefficient ϕ was calculated for every relevé group (the so-called 'cluster') and its value was irrespective of group size [Tichý and Chytrý 2006]. Species was established as diagnostic when its ϕ value amounted to 10 or more, whereas for constant species the threshold of 20% coverage was set. At the same time, distinction of dominant species took place at the standard threshold of over 50% coverage and its occurrence in at least 3% of the relevés in the group [Kącki 2012].

Table 1. Scale of intensity of pasture use

Degree	Maximum amount of annual fertilization dose $kg^{-1} \cdot ha^{-1}$			Density $LU^{-1} \cdot ha^{-1}$	Grazing system
	N	P	K		
Low (+)	50	10	30	1	free grazing
Moderate (++)	120	25	60	2-2.5	rotational grazing
High (+++)	200	35	120	3-4	strip grazing

LU – livestock unit

RESULTS

In the analyzed relevés, 178 species of vascular plants from 33 families were noted, of which the most numerous and with the highest participation were *Poaceae, Asteraceae*, and *Fabaceae*. Over 60% of the species were hemicryptophytes (Table 2). Due to appearing human impact on the environment in the communities which are mesohemerobic and include mainly semi-natural plants, most of them are native species, which may grow in plant communities of higher degree of hemeroby, related to the habitats of high intensity of human impact. Also alien species were noted, mostly archaeophytes (Table 2). Among the forage plat groups, dicotyledons dominate in the sward, the so-called herbs and weeds (65%), but they often occur with a low degree of quantity.

Area inspections and relevé analysis demonstrated diversification in the species composition of *Lolio-Cynosuretum* phytocenoses, and moreover in species abundance marked with the H' index.

Differences in the floristic composition gave basics to distinguishing within the studied *Lolio-Cynosuretum* phytocenoses four subassociations and eight variants within them. Their classification is as follows:

Class: *Molinio-Arrhenatheretea* R.Tx. 1937
Order: *Arrhenatheretalia elatioris* Pawł. 1928
Alliance: *Cynosurion* R.Tx. 1947
Association: *Lolio-Cynosuretum* R.Tx. 1937
subassociation: *L.-C. typicum*
typical variant
variant with *Agrostis gigantea*
subassociation: *L.-C. trifolietosum repenti*
typical variant
variant with *Poa pratensis*
variant with *Armeria maritima* ssp. *elongata*

subassociation: *L.-C. dactylidetosum glomeratae*
typical variant
variant with *Bromus horeaceus*
subassociation: *L.-C. plantaginetosum majoris*
typical variant

Table 2. Floristic diversity of the *Lolio-Cynosuretum* association compared to life forms, geo-historical spectrum, and forage groups of plant (share in %)

	Syntaxon							
	1	2	3	4	5	6	7	8
Intensity of pasture use	++	+	++	++	+	+++	++	+
Life form								
Chamaephytes	7	8	6	6	5	5	3	4
Dwarf-shrubs	2	0	2	1	1	1	2	0
Hemicryptophytes	60	67	59	63	65	62	57	62
Geophytes	13	10	14	14	13	16	9	20
Hydrophytes/helophytes	3	5	5	4	0	1	5	0
Therophytes	16	11	14	12	16	14	25	14
Geo-historical spectrum								
Native species	90	98	86	91	90	86	85	95
Archaeophytes	7	2	8	5	6	12	9	3
Kenophytes	2	0	4	3	3	3	5	3
Diaphytes	1	0	1	0	1	0	0	0
Synantropic hybrids	0	0	1	1	0	0	2	0
Forage groups of plant								
Grasses	21	29	23	28	25	27	26	42
Sedges	7	5	6	5	4	4	3	3
Legumes	7	6	12	10	9	5	11	9
Herbs and weeds	65	60	59	56	62	64	60	46

1 – *L.-C. typicum*, 2 – *L.-C. typicum* variant with *Agrostis gigantea*, 3 – *L.-C. trifolietosum repenti*, 4 – *L.-C. trifolietosum* variant with *Poa pratenis*, 5 – *L.-C. trifolietosum* variant with *Armeria maritima ssp. elongata*, 6 – *L.-C. dactylidetosum glomeratae*, 7 – *L.-C. dactylidetosum* variant with *Bromus hordeaceus*, 8 – *L.-C. plantaginetosum majoris*
\+ low, ++ moderate, +++ high

For every one of them, it is possible to indicate, except the species characteristic to the unit, also diagnostic, constant, and dominant species (Table 3). For example, *Lolio--Cynosuretum typicum* is characterized by the constant presence of *Achillea millefolium* and *Heracleum sphondylium,* whereas for *L.-C. trifolietosum repenti,* dominant participation of *Trifolium repens* and *T. pratense*, as well as *Taraxacum officinale* is characteristic. On the other hand, in *L.-C. dactylidetosum glomeratae*, high participation of grass can be found in the sward, as well as of dandelion. Except plant from the *Poaceae* family, in the sward *L.-C. trifolietosum repenti* variant with *Poa pratensis* legumes and other dicotyledons dominate. In the case of *Plantago major,* in spite of high consistency of this species in every distinguished relevé groups, only in two subassociations, namely *L.-C. dactylidetosum glomeratae* variant with *Bromus hordeaceus* and *L.-C. platanginetosum majoris,* it obtained the species status, successively, constant and diagnostic (demonstrating fidelity).

Table 3. Synoptic table of the *Lolio-Cynosuretum* association with diagnostic, constant, and dominant species for syntaxa

Group number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
No. of relevés	29	7	16	10	8	13	7	10
Total number of plant species	106	63	101	78	77	77	65	35
Mean number of plant species per relevé	19	20	21	22	18	19	17	11
H' – Shannon-Wiener index	2.26	2.55	2.30	2.45	2,43	2.21	2.05	1.72
Ch. and *D. Lolio-Cynosuretum*								
Trifolium repens	IV^{---}	V^{---}	V$^{25.4}$	V^{---}	IV^{---}	IV^{---}	III^{---}	V^{---}
Lolium perenne	V^{---}	V^{---}	V^{--}	III^{---}	V^{---}	V^{---}	IV^{---}	IV^{---}
Bellis perennis	I^{---}	I^{---}	II$^{10.8}$	II^{---}	.$^{---}$	I^{---}	.$^{---}$	.$^{---}$
Cynosurus cristatus	.$^{---}$	I^{---}	II$^{14.3}$	III$^{16.6}$	.$^{---}$	II^{---}	.$^{---}$	.$^{---}$
Leontodon autumnalis	II^{---}	.$^{---}$	I^{---}	.$^{---}$	I^{---}	I^{---}	I^{---}	II^{---}
Lower unit species								
Heracleum sphondylium	III$^{15.2}$	I^{---}	I^{---}	.$^{---}$	.$^{---}$	II^{---}	.$^{---}$	I^{---}
Lamium purpureum	I$^{12.0}$	.$^{---}$	I^{---}	.$^{---}$	.$^{---}$	.$^{---}$	.$^{---}$	.$^{---}$
Daucus carota	II$^{10.7}$	.$^{---}$	.$^{---}$	I^{---}	I^{---}	.$^{---}$	.$^{---}$	.$^{---}$
Cardamine pratensis	II$^{11.8}$	I^{---}	I^{---}	I^{---}	.$^{---}$	I^{---}	I^{---}	.$^{---}$
Deschampsia caespitosa	III$^{10.6}$	IV$^{10.5}$	II^{--}	III^{---}	II^{---}	I^{---}	I^{---}	.$^{---}$
Agrostis gigantea	I^{---}	V$^{35.7}$	I^{--}	I^{---}	.$^{---}$	II^{---}	II^{---}	IV$^{9.2}$
Rumex acetosa	III^{---}	V$^{21.7}$	II^{--}	III^{---}	IV^{---}	II^{---}	II^{---}	I^{---}
Crepis biennis	I^{---}	II$^{17.9}$	.$^{--}$	.$^{---}$	I^{---}	.$^{---}$	.$^{---}$	.$^{---}$
Holcus lanatus	II^{---}	III$^{11.9}$	I^{--}	II^{---}	III^{---}	I^{---}	.$^{---}$	.$^{---}$
Ranunculus repens	III^{---}	V$^{13.5}$	IV$^{6.1}$	III^{---}	III^{---}	II^{---}	.$^{---}$	.$^{---}$
Trifolium pratense	II^{---}	II^{---}	V$^{15.7}$	III^{---}	II^{---}	II^{---}	II^{---}	.$^{---}$
Plantago media	I^{---}	.$^{---}$	I$^{13.1}$	.$^{---}$	.$^{---}$	.$^{---}$	.$^{--}$	.$^{---}$
Rorippa amphibia	.$^{---}$	.$^{---}$	I$^{11.8}$	.$^{---}$	.$^{---}$	.$^{---}$	I^{---}	.$^{---}$
Festuca pratensis	I^{---}	I^{---}	II^{---}	III$^{43.8}$	.$^{---}$	II^{---}	.$^{---}$	.$^{---}$
Carex hirta	I^{---}	I^{---}	II^{---}	III$^{21.3}$	I^{---}	I^{---}	.$^{---}$	.$^{---}$
Poa pratensis	III^{---}	IV^{---}	IV^{---}	V$^{21.2}$	II^{---}	III^{---}	II^{---}	II^{---}
Trifolium dubium	.$^{---}$	.$^{---}$	I^{---}	II$^{13.5}$	.$^{---}$	I^{---}	.$^{---}$	.$^{---}$
Juncus effusus	I^{---}	.$^{---}$	.$^{---}$	I$^{17.0}$	.$^{---}$	.$^{---}$	.$^{---}$	.$^{---}$
Armeria maritima ssp. *elongata*	I^{---}	I^{---}	.$^{---}$	.$^{---}$	II$^{26.4}$	I^{---}	.$^{---}$	.$^{---}$
Arrhenatherum elatius	.$^{---}$	.$^{---}$	I^{---}	.$^{---}$	II$^{14.8}$	I^{---}	.$^{---}$	.$^{---}$
Galium verum	.$^{---}$	.$^{---}$	I^{---}	I^{---}	II$^{14.4}$	.$^{---}$	I^{--}	.$^{---}$
Lychnis flos-cuculi	I^{---}	.$^{---}$	I^{---}	I^{---}	II$^{13.1}$	.$^{---}$	.$^{---}$	.$^{---}$
Dactylis glomerata	II^{---}	.$^{---}$	III^{---}	III^{---}	I^{---}	V$^{39.3}$	III^{---}	II^{---}
Festuca rubra	III^{---}	IV^{---}	IV^{---}	II^{---}	II^{---}	V$^{21.0}$	III^{---}	.$^{---}$
Phleum pratense	III^{---}	I^{---}	II^{---}	III^{---}	.$^{---}$	IV$^{13.9}$	II^{---}	I^{---}
Bromus hordaceus	II^{---}	I^{---}	I^{---}	I^{---}	III^{---}	II$^{38.1}$	III$^{14.3}$	I^{---}
Matricaria inodora	.$^{---}$	.$^{---}$	.$^{---}$	.$^{---}$	.$^{---}$	I^{---}	II$^{26.8}$	.$^{---}$
Pimpinella major	.$^{---}$	.$^{---}$	.$^{---}$	.$^{---}$	.$^{---}$	.$^{---}$	II$^{24.9}$	.$^{---}$
Elymus repens	I^{---}	II^{---}	.$^{---}$	I^{---}	II^{---}	I^{---}	III$^{14.0}$	I^{---}
Chenopodium album	I^{---}	I^{---}	.$^{---}$	.$^{---}$	.$^{---}$	.$^{---}$	III$^{15.2}$	III$^{11.3}$
Poa annua	I^{---}	.$^{---}$	.$^{---}$	I^{---}	I^{---}	.$^{---}$	II^{---}	IV$^{47.0}$
Plantago major	III^{---}	II^{--}	III^{---}	III^{---}	II^{---}	II^{---}	III^{---}	V$^{28.3}$
Alopecurus geniculatus	.$^{---}$	II^{---}	.$^{---}$	.$^{---}$	.$^{---}$	.$^{---}$	I^{---}	II$^{25.7}$
Erodium cicutarium	.$^{---}$	.$^{---}$	.$^{---}$	.$^{---}$	.$^{---}$	.$^{---}$	.$^{---}$	I$^{18.7}$
Medicago lupulina	I^{---}	I^{---}	I^{---}	.$^{---}$	I^{---}	.$^{---}$	I^{---}	II$^{14.5}$
Poa palustris	.$^{---}$	.$^{---}$	.$^{---}$	.$^{---}$	.$^{---}$	.$^{---}$	I^{---}	II$^{24.5}$

Table 3 continue

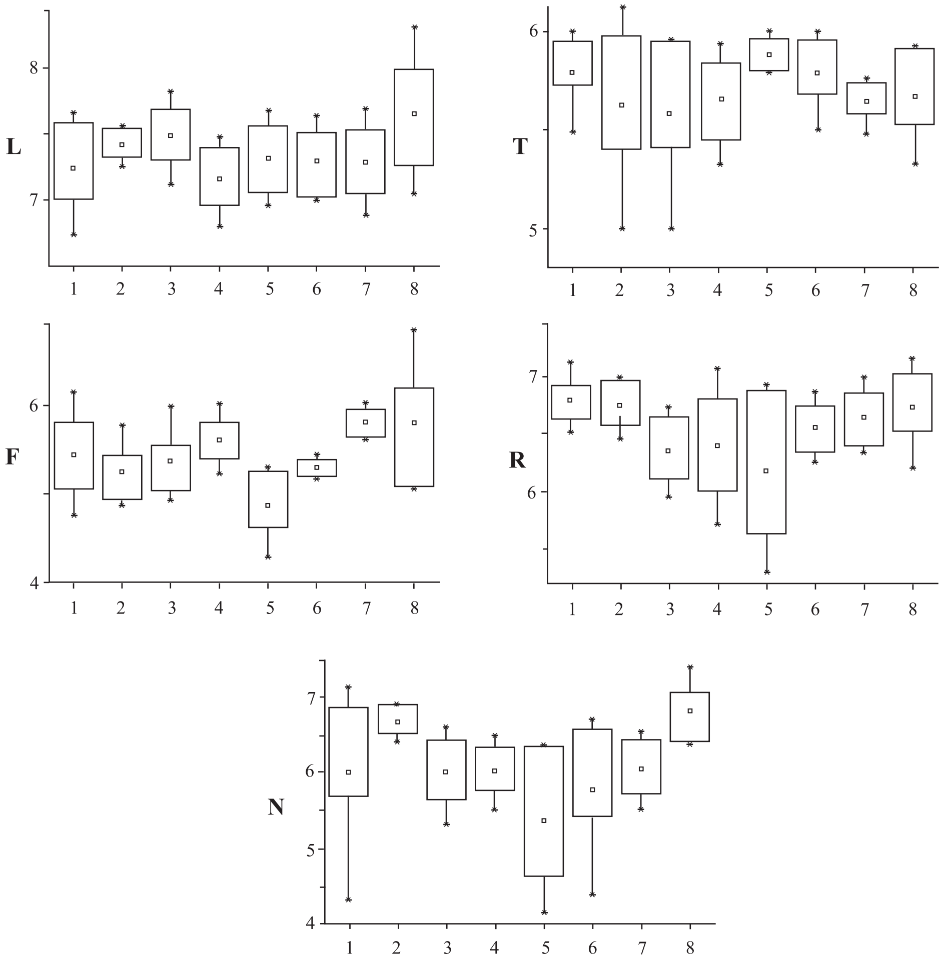
Polygonum amphibium	. $^{---}$	I $^{---}$	I $^{---}$	. $^{---}$	. $^{---}$	. $^{---}$	. $^{---}$	I $^{9.5}$
Achillea millefolium	IV $^{---}$	V $^{---}$	V $^{---}$	III $^{---}$	IV $^{---}$	V $^{---}$	V $^{---}$	II $^{---}$
Taraxacum officinale	IV $^{---}$	III $^{---}$	V $^{---}$	V $^{---}$	III $^{---}$	V $^{---}$	V $^{---}$	IV $^{---}$
Potentilla anserina	III $^{9.2}$	II $^{---}$	III $^{---}$	III $^{---}$	I $^{---}$	II $^{---}$	I $^{---}$	II $^{---}$
Cirsium arvense	III $^{7.4}$	. $^{--}$	II $^{--}$	III $^{---}$	I $^{---}$	II $^{---}$	II $^{---}$	. $^{---}$
Urtica dioica	III $^{6.6}$	. $^{---}$	II $^{-}$	I $^{---}$	II $^{---}$	I $^{---}$	I $^{---}$	I $^{---}$
Veronica chamaedrys	I $^{---}$	I $^{---}$	I $^{-}$	II $^{8.4}$	. $^{---}$	I $^{---}$	. $^{--}$	. $^{---}$
Alopecurus pratensis	III $^{---}$	IV $^{---}$	III $^{-}$	III $^{---}$	II $^{---}$	III $^{---}$	II $^{---}$	I $^{---}$
Plantago lanceolata	III $^{---}$	II $^{---}$	II $^{-}$	III $^{---}$	IV $^{---}$	III $^{---}$	II $^{---}$	I $^{---}$
Ranunculus acris	III $^{---}$	III $^{---}$	III $^{-}$	III $^{---}$	I $^{---}$	IV $^{---}$	II $^{---}$	. $^{---}$
Phalaris arundinacea	III $^{---}$	III $^{---}$	II $^{-}$	II $^{---}$	II $^{---}$	II $^{---}$	I $^{---}$	I $^{---}$
Stellaria media	II $^{---}$	II $^{---}$	II $^{-}$	I $^{---}$	III $^{---}$	II $^{---}$	II $^{---}$	. $^{---}$
Rumex crispus	II $^{---}$	. $^{---}$	III $^{-}$	II $^{---}$	II $^{---}$	II $^{---}$	. $^{---}$	I $^{---}$
Festuca ovina	. $^{---}$	. $^{---}$	. $^{---}$	. $^{---}$	I $^{---}$	I $^{7.3}$	. $^{---}$	. $^{---}$
Glechoma hederacea	II $^{---}$	III $^{---}$	I $^{-}$	I $^{---}$	I $^{---}$	II $^{---}$	I $^{---}$	. $^{---}$
Cerastium holosteoides	I $^{---}$	III $^{---}$	I $^{-}$	I $^{---}$	I $^{---}$	II $^{---}$	. $^{---}$	I $^{---}$

1 – *L.-C. typicum*, 2 – *L.-C. typicum* variant with *Agrostis gigantea*, 3 – *L.-C. trifolietosum repenti*, 4 – *L.-C. trifolietosum* variant with *Poa pratenis*, 5 – *L.-C. trifolietosum* variant with *Armeria maritima* ssp. *elongata*, 6 – *L.-C. dactylidetosum glomeratae*, 7 – *L.-C. dactylidetosum* var. with *Bromus hordeaceus*, 8 – *L.-C. plantaginetosum majoris*
III $^{11.3}$ – degree of species consistency and fidelity, [solid box] diagnotic species, [dashed box] constant species, [dash-dot box] dominant species

Unit diversification on floristic grounds was compared with the values of the calculated geo-botanical indicators. The greatest effect of the climate and habitat conditions, determined phytoindicatively, on the diversity of the *Lolio-Cynosuretum* subassociations was noted at indicators N, F, and L (Fig. 1).

The greatest range of geo-botanical indicators was noted for N, but only three groups of relevés were clearly diagnosed on the basis of this measurement instrument. Narrow range of soil fertility indicator was observed for *L.-C. typicum* variant with *Agrostis gigantea*, whereas in the group *L.-C. trifolietosum* variant with *Armeria maritima* ssp. *elongata*, the range of N was the widest. At the same time, the *L.C. plantaginetosum majoris* phytocenoses were characterized by a higher presence of nitrogenphilic species, and therefore the average N indicator for this group of relevés reached explicitly the highest value (Fig. 1, Table 4).

Moreover, the distinguished phytocenoses demonstrate also diversification in regards to humidity, which is confirmed by the calculated values of the F indicator. Therefore, it may be assumed that the above indicator appears to be one for monitoring the changes in the level of ground waters at the *Lolio-Cynosuretum* posts. This is particularly confirmed by the F-values calculated for the phytocenoses with the dominance of *Plantago lanceolata* (*L.-C. trifolietosum* variant with *Armeria maritima ssp. elongata)* and *Taraxacum officinale* (*L.-C. dactylidetosum glomeratae* variant with *Bromus hordeaceus*). They were formed according to the increasing gradient of habitat humidity. *L.-C. trifolietosum* variant with *Armeria maritima ssp. elongata* was noted in the least humid habitats, which points to an average F indicator of 4.94. It ought to be assumed that humidity conditions contribute to the occurrence of differences between the syntaxa in the average number of species per piece and in floristic diversity (H').



Explanation: number of groups under axis X is the same as in Table 3

Fig. 1. Box charts for the *Lolio-Cynosuretum* associations show the rate of Ellenberg indicators

Similarly, light intensity L demonstrated to be a good indicator, in particular in the case of *L.C. plantaginetosum majoris*, and moreover for *L.-C. trifolietosum* variant typical and *L.-C. trifolietosum* variant with *Poa pratensis.* Phytocenoses *L.C. plantaginetosum majoris* are characterized by a greater presence of nitrogenphilic species. At the same time, the subassociation was characterized by the lowest average number of species in the relevé and the H' index, as well as low and loose sward, which was represented in the highest value of light availability index (L = 7.62). On the other hand, in the dense, rich in species sward of phytocenoses *L.-C. trifolietosum* variant with *Poa pratensis,* high participation of plants of moderate light was observed, which is confirmed by the lowest value of the light indicator (L = 7.18). It ought to be noted that the calculated values of thermal and pH indicators do not always depend on the floristic diversity of the subassociations evaluated with the H' value (Fig. 1, Table 4).

Table 4. Subsyntaxa of *Lolio-Cynosuretum* and their average habitat indicators

Syntaxon	Ellenberg indicator				
	L	T	F	R	N
L-C typicum	7.29	7.29	7.29	7.29	7.29
L-C typicum variant with *Agrostis gigantea*	7.29	7.29	7.29	7.29	7.29
L-C trifolietosum repenti	7.49	7.49	7.49	7.49	7.49
L-C trifolietosum repenti variant with *Poa pratensis*	7.18	7.18	7.18	7.18	7.18
L-C trifolietosum repenti variant with *Armeria maritime* ssp. *elongata*	7.31	7.31	7.31	7.31	7.31
L-C dactylidosum glomeratae	7.27	7.27	7.27	7.27	7.27
L-C dactylidosum glomeratae variant with *Bromus hordeaceus*	7.43	7.43	7.43	7.43	7.43
L-C plantaginetosum majoris	7.62	7.62	7.62	7.62	7.62
Lolio-Cynosuretum	7.35	7.35	7.35	7.35	7.35

Floristic diversity of the subassociations and variants of *Lolio-Cynosuretum* demonstrates itself also in the structure of life forms, geographical and historical spectrum, and utility groups. With the increase in the intensity of pasture area utilization, a tendency for higher participation of alien species, including archaeophytes, appears. The lowest number of alien plants was found in phytocenoses *L.C. plantaginetosum majoris* and *L-C typicum* variant with *Agrostis gigantea*, and the highest number on rotation pastures (density over 2 DJP·ha^{-1}) and with the use of high NPK doses (250-300 kg·ha^{-1}) in *L.-C. dactylidetosum glometratae* variant typical and variant with *Bromus hordeaceus.* Relation between utilization intensity and the structure of life forms is less clear. However, with the increase in utilization intensity, the average number of species per relevé decreased, as did the participation of legumes (Table 2).

DISCUSSION

Taking into account the structure of the root systems of the plant species that grow in pastures, the main ecological factor that affects the diversification of species composition is precipitation sum and distribution during growth [Zuidhoff *et al.* 1995], and subsequently anthropo- and zoo-biotic factors [Szoszkiewicz 1967]. On the basis of the data from the many-years' period of 1971-2000, it results that in the areas of the analyzed valleys, precipitation sum oscillates between similar levels of circa 350-400 mm. Moreover, the geographical location of the studied phytocenoses in all the valleys indicates that they take up a lowland shape. Zuidhoff *et al.* [1995], Rozbrojová *et al.* [2010], Kuzemko [2011], and Chytrý [2012] distinguish two forms of pasture communities in Europe, which represent the alliance *Cynosurion cristati*, namely mountain and lowland communities. They differ in the combination of diagnostic species, among which attention is paid to the frequent occurrence with high consistency in the lowland form of such species as: *Bellis perennis, Achillea millefolium, Agrostis capillaris,* and *Carex hirta* [Dierschke 1994, Zuidhoff *et al*. 1995, and Rozbrojová *et al.* 2010]. Therefore, both the weather conditions, mainly precipitation, as well as geographical location are not factors that affect to a higher extent the marked differences in the floristic composition of pasture communities formed in the analyzed valleys.

However, taking into account the fact that meadow communities are dynamic systems and depend on the habitat conditions and human actions [Barabasz 1997, Zarzycki 1999, Kryszak and Grynia 2001, Kryszak *et al.* 2010, Kącki 2012], they undergo frequent transformations, the expression of which is the occurrence of numerous units lower than association.

In order to form grass communities, and also others, habitat humidity is a particularly important factor. It affects also the botanical composition of *Lolio-Cynosuretum*, and consequently its syntaxonomic diversification. This was confirmed by the results published in the present work, which demonstrate that the factor in a significant way diversifies the floristic composition of *Lolio-Cynosuretum* phytocenoses. It concerns in particular: *L.-C. typicum* variant with *Agrostis gigantea, L.-C. dactylidetosum* variant with *Bromus hordeaceus,* and *L.-C. trifolietosum* variant with *Armeria maritima ssp. elongata.* Taking into account the fact that soil richness in the available nutrients, especially soils of organic origin, demonstrates a relation with habitat humidity, for the users, information on the species composition and phytoindication diagnosis conducted on the basis of it will make it possible to make a decision on fertilization and the need to perform drainage equipment maintenance [Landolt 1977].

In addition, sward grazing and its intensity has a significant effect on the diversification of the floristic composition of the alliance *Lolio-Cynosuretum*, as does mowing and grazing utilization, which change the ecological conditions for plant growth and development [Rogalski 1996, Kryszak *et al*. 2010]. Animal grazing, at high density, causes selective biting out of plants, and the excrements that are left behind limit the species number in the sward, including low perennials and some grass species [Rogalski *et al.* 1999, Trąba and Wyłupek 2000, Trąba *et al.* 2008]. On the other hand, change in utilization to alternating contributes to the increase in the biological diversity of phytocenoses and in the participation of species that eliminate mowing and grazing. Fertilization with high nitrogen doses and high animal density cause an increase in soil richness in nitrogen, the result of which is significant presence in the sward of, among others, *Dactylis glomerata* [Mosek 2000, Kryszak and Kryszak 2001]. This type of utilization leads to the formation of the subassociation *L.-C. dactylidetosum glomeratae* phytocenoses, which are characterized by low biodiversity. Therefore, *Dactylis glomerata* could play the role of a differential species for the subassociation *Lolio-Cynosuretum.* Similar function for other syntaxa of the above community could be played by the species proposed in Table 2.

Location of pastures in relation to the farm, as well as habitat humidity, determine the intensity of their utilization. Pastures situated in the vicinity of farms, often extensively grazed, are characterized by the presence of species from class *Artemisietea* and order *Plantaginetalia majoris.* Species composition of such areas gave basis for Tumidajowicz [1971] and Bator [2005] to distinguish the subassociation *L.-C. poetosum annuae.* Very similar syntaxon was distinguished within the present work, namely *L.-C. plataginetosum majoris*, which is also characterized by high participation of flooded sward species. Differences between the two subassociations demonstrate themselves at the level of human impact on the environment. *L.-C. poetosum annuae* positions itself by gardens and buildings, whereas the other subassociation occupies more humid niches in pastures *sensu stricto*.

However, taking into account the fact that habitat conditions undergo frequent changes, also as a result of human actions, and demonstrate relations between themselves, it is sometimes hard to indicate unambiguously the cause of given floristic composition of pastures of anthropogenic origin, which grass communities are, including *Lolio-Cynosuretum* phytocenoses.

CONCLUSIONS

1. Diversity in the floral composition of *Lolio-Cynosuretum* phytocenoses is related to the habitat conditions, which may be evaluated on the basis of the ecological preferences of the plant species that form them.

2. Species changes in typical *Lolio-Cynosuretum* phytocenoses may be an indicator of the occurring changes in the habitat conditions and may give basis to distinguish units lower than association.

3. In the conditions of diversified humidity, the following subassociations were distinguished:

a) *Lolio-Cynosuretum typicum* variant with *Agrostis gigantea* at higher humidity,

b) *Lolio-Cynosuretum dactylidetosum* variant with *Bromus hordeaceus* and *Lolio--Cynosuretum trifolietosum* variant with *Armeria maritima* ssp. elongata as subassociations that indicate habitat overdrying.

4. In the conditions of lower light availability but high soil richness in nitrogen compounds, the following subassociations are formed: *Lolio-Cynosuretum dactylidosum glomeratae* and *Lolio-Cynosuretum trifolietosum* variant with *Poa pratensis*.

5. Phytoindication diagnoses may constitute important information for the users (farmers) on the need to control the habitat conditions, mainly humidity, soil pH, and its richness in nutrients.

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ZRÓŻNICOWANIE FLORYSTYCZNE ZESPOŁU *Lolio-cynosuretum* R. TX. 1937 JAKO WSKAŹNIK WARUNKÓW SIEDLISKOWYCH

Streszczenie. Zmieniający się skład florystyczny zbiorowisk łąkowych i pastwiskowych może dostarczyć informacji o działalności człowieka w zakresie modyfikacji warunków siedliskowych i intensywności użytkowania. Celem pracy było przedstawienie zróżnicowania florystycznego zespołu *Lolio-Cynosuretum* oraz jego powiązanie z warunkami siedliskowymi ocenionymi metodą fitoindykacji z zastosowaniem wskaźników Ellenberga i in. Badania prowadzono w pięciu dolinach rzecznych w latach 1999-2012. Do analizy wybrano zbiór 100 zdjęć fitosocjologicznych, które poddano analizie pod względem składu florystycznego, wymagań ekologicznych gatunków oraz statystycznym. W fitocenozach *Lolio-Cynosuretum* zanotowano łącznie 178 taksonów roślin naczyniowych z 33 rodzin. Wykazano, że zróżnicowanie składu florystycznego fitocenoz zespołu *Lolio-Cynosuretum* pozostaje w związku z warunkami siedliskowymi, które można ocenić na podstawie preferencji ekologicznych budujących je gatunków roślin. Gatunki te uznano jako wyróżniające dla niższych jednostek, tj. 4 podzespołów i 8 wariantów.

Słowa kluczowe: fitoindykacja, *Lolio-Cynosuretum*, podzespoły, warianty, warunki siedliskowe, zróżnicowanie florystyczne

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